

and *Alcyonidium parasiticum*, all more or less rare on the English coast, are tolerably abundant in these situations. I might enlarge upon this subject, but the data are at present too few to admit of our doing so with certainty.

Many species appear to attain a much greater height in Ireland than in England, as will be evident on a comparison of the sizes given in Dr. Johnston's elegant work and in this Catalogue: this is probably attributable to the mildness of the climate.

EXPLANATION OF THE PLATES.

PLATE V. Fig. 1. *Antennularia ramosa*.

Fig. 2. A portion of the same magnified.

Fig. 3. A portion of *A. antennina* magnified, showing the small tubular cells placed between the larger ones, and which are absent in *A. ramosa*.

PLATE VI. Fig. 1. A specimen of *Farcimia sinuosa*, of the natural size.

Fig. 2. A portion of the same magnified.

Fig. 3. and 4. Specimens of *Tubulipora verrucaria*; in the one the tubes are separate, in the other united.

Fig. 5. *Lepralia 4-dentata*.

PLATE VII. Fig. 1. *Flustra Hibernica*. This is a very imperfect representation of the original, the exact appearance of which it is very difficult to represent in a drawing.

Fig. 2. *Melobesia elegans* of Mr. Bean, magnified.

Fig. 3. and 4. *Crisia aculeata*, a new species.

XXII.—*A Synopsis of the Genera and Species of the Class Hypostoma (Asterias, Linnæus)*. By JOHN EDWARD GRAY, Esq., F.R.S., Keeper of the Zoological Collection in the British Museum.

My intention in sending this paper to the press is not only to bring before the public a number of new genera and species which have been for several years in the collection of the British Museum, but also to attempt to divide what has hitherto been considered an intricate Class into natural groups, to subdivide these groups and the genera they contain into smaller sections, so as to facilitate the determination of the species, and at the same time to assist in making out the natural affinities of this much-neglected group of animals.

Hitherto very few persons have attempted to divide the Starfishes (*Asterias*, Linn.) into natural groups, and it is but recently that Nardo, and subsequently M. Agassiz, have paid any attention to the good groups pointed out by the first author of anything like a Monograph of these animals, I mean of Henry Linck, who published a separate work on the subject in folio, which he dedicated to Sir Hans Sloane and the members of the Royal Society. Nardo has done little more, as I shall presently show, than rename Linck's divisions; and M. Agassiz has followed in Nardo's footsteps, adding one or

two fossil genera which did not come within Linck's or Nardo's object. Mr. Edward Forbes has lately published a description of some Manx species, in which he has divided the *Stellonia* of Nardo into two genera, and added a genus which he calls *Luidia* for a species not known to Linck: he has also used the number of series of suckers (a character noticed by Müller and others) as a generic one.

Linck divides the Starfishes (*Asterias*, Linn.) into two great groups by the presence or absence of the ambulacra on the lower side of the arms, calling the first, which exactly agrees with the *Asterias* of Lamarck, the *Asteriadae* of this paper, "*stellis fissis*," and the second "*stellis integris*." The latter group he divides into three classes: viz.

1. *Stellis vermiformibus* = the *Ophiura* of Lamarck.

2. *Stellis crinitis*? = the *Comatula* of the same author.

3. *Astrophyton*, which is the *Euryale* of the same. Thus we see, that he distinguished all the natural groups, which were afterwards thrown together into a single genus to be artificially divided into sections by Linnæus and his followers. Linck's groups were not again recognized until nearly half a century after the publication of his valuable work.

In dividing the fissured Starfishes, or *Asteriadae* as we call them in modern nomenclature, into genera, Linck began badly by paying too much attention to the number of the rays, though it is evident, by the names he has given to the different species in his genera, that he was aware that some which he separated on this account were very nearly allied to each other. Overlooking the genera which are formed solely on this character, such as *Trisactis*, *Tetractis*, *Hexactis* and *Heptactis*, which are all formed on varieties or distortions of other species, we shall find that the others noticed by him are excellent genera, and such as are now acknowledged. His

1. *Pentanogaster* = *Goniaster* (*) *Agassiz*. *Scutasteries*, *Blainv.*

2. *Pentaceros* = *Goniaster* (**) *Agassiz*. *Asterina*, *Nardo*. *Platasteries*, *Blainv.*

3. *Astropecten* = *Stellaria*, *Nardo*. *Asterias*, *Agassiz*.

4. *Palmipes* = *Anseropoda*, *Nardo*. *Palmasteries*, *Blainv.*

5. *Stella coriacea* = *Stellonia*, *Forbes*. *Stellonia*, part, *Nardo*. *Pentasteries* and *Solasteries*, *Blainv.*

6. *Pentadactylosaster* = *Cribella*, *Agassiz* not *Edwards*. *Linckia*, *Nardo* not *Agassiz*.

| | |
|------------------------------|---|
| 7. <i>Octactis</i> , | } = <i>Solaster</i> , <i>Forbes</i> . <i>Stellonia</i> , part, <i>Nardo</i> and <i>Agassiz</i> . |
| 8. <i>Enneactis</i> , | |
| 9. <i>Decactis</i> , | |
| 10. <i>Dodecactis</i> , | |
| 11. <i>Triskaidecactis</i> , | |

Nardo, in the *Naturforscher* for 1833, and in the *Isis* for 1834, p. 716, gives the following arrangement of the European species, which he divides into five genera:—

1. *Stellaria* = *Astropecten*, *Linck*.

2. *Stellonia* = *Stella coriacea*, *Linck*, and his other genera above enumerated.

3. Asterina : Linck only knew one species which he put at the end of his *Pentaceros*.

4. Anseropoda = Palmipes, *Linck*.

5. Linckia = Pentadactylosaster, *Linck*.

M. Agassiz, in the Memoirs of the Neufchatel Society, published a new arrangement of the *Echinodermata*, which has been abridged into the *Annales des Sciences Naturelles*, and from thence translated into the *Annals of Natural History*, i. 440, in which he has changed the names of some of Nardo's genera, and added some others for extra-European and fossil species, as follows :—

1. Asterias = Astropecten, *Linck*. = Stellaria, *Nardo*.

2. Cœlaster, fossil.

3. Goniaster = Pentagonaster and Pentaceros, *Linck*.

4. Ophiaster, a new species.

5. Linckia = Cribella = Pentadactylosaster, *Linck*.

6. Stellonia, *Nardo* = Stella coriacea, *Linck*, &c., as above.

7. Asterina, *Nardo*.

8. Palmipes, *Linck*. = Anseropoda, *Nardo*.

9. Culcita, *Agassiz*, for Ast. discoidea, *Lam*.

M. Agassiz generally quotes for the type of his European genera the same species as those cited by Nardo.

Class HYPOSTOMA, *Gray, Syn. Brit. Mus.*

Having a bag-like stomach, with a single opening serving as mouth and vent. The ovarian pores are placed round the mouth. The body is inclosed in a hard skin and supported by variously shaped calcareous pieces.

It should be remarked, that the hard parts of these animals, whether they are in the form of *tesseræ*, as in the *Echinida*, or of *ossicula*, as in the *Hypostomata*, or in that of spines, as in either, are evidently the hardening of certain parts of the cellular substance or skin, and these hard parts retain their organization and vitality during the life of the animal ; consequently they are not inorganic secretions, like the shells of mollusca, as they have generally been considered, but have far more relation to bones and coral, and like them form a peculiar kind of body intermediate between shells and the skeletons of vertebrata. "These pieces," as I have observed in the Synopsis of the British Museum, "are formed by the earthy particles being deposited round certain definite spots in the skin, and as they are developed they assume a definite arrangement into certain distinct shapes peculiar to the different kinds : although these are strongly united together by the skin, and have a kind of organization during the life of the animal, they may easily be separated from each other after death, and then appear like separate bones. This structure allows the animal to increase both the size and the number of the pieces that compose its protecting case as the body grows, and also to repair, by the deposition of fresh calcareous particles on the skin of the healed part, any injury which the animal may have received from external accidents during its life."

This structure is not so easily demonstrated in the internal bones
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of the Starfishes as it is in the external tesseræ of the Sea Eggs, and in the spines of both these kinds of animals, as they are often to be found broken and repaired during their growth, and this repair does not take place by any secretion applied to their surface, but by a healing of the part, which leaves a scar on the surface. Nevertheless, the entire similarity which exists between the external spines and the internal tubercles at once shows that they are of the same structure; and this is further proved by the examination of the tubercles of those kinds which are in great part exposed on the surface, as is the case with the different kinds of *Pentaceros*, where the development of these hard parts can often be observed during the process of reproducing an arm that has been accidentally injured or destroyed.

The specimens described in this synopsis are either in the collection of the British Museum or in that of the Zoological Society, which includes the specimens discovered by Mr. Cuming during his residence in South America, and presented by him to the Society.

Order 1. ASTEROIDA.

Body free, star-shaped, with distinct small ambulacra (or walks) of double pores on the oral surface, from the mouth to the ends of the rays; dorsal wart distinct.

These animals have the faculty of reproducing the arms or such parts as may be accidentally broken off; and if an entire arm be separated, provided part of the body be attached to it, other arms are reproduced, and a fresh perfect animal formed.

SECT. 1. *The Ambulacra with four rows of feet; dorsal wart simple.*

Family 1. ASTERIADÆ, Gray, *Syn. Brit. Mus.* 62.

Asteracanthus m. 14

1. ASTERIAS.

Skeleton netted with a single mobile spine at each anastomosis of the ossicula; body covered with more or less prominent elongated mobile spines*.

a. *Rays 12 or 13, slender, tapering, with small elongated spines.*

1. *Asterias Aster*, Gray. Rays 3 times as long as the diameter of the body; back with 7 series of spines, the labial spine at the angles of the arms very long.

Inhab. —. Brit. Mus.

* Some continental zoologists have objected to the shortness of my generic and specific characters; and I therefore think it right to observe, that it does not seem to me either necessary or desirable to give more than the essential distinguishing marks, in a monograph founded on the complete analysis of a large collection of species. On the other hand, it appears to me to be quite right, in the publication of a single supposed new genus or species, or of a limited number of them, where the author either wants the materials or the time for a rigid examination of the entire group, to give all the assistance that can be derived from a detailed description. No naturalist will doubt which is the easier process; and few, I think, will hesitate as to which is the most advantageous to science.

b. Rays 6 or 8 cylindrical. *m. 19*

2. *Asterias calamaria*, Gray. Arms four times as long as the diameter of the body, with 7 ridges of spines; the 5 dorsal ridges equidistant.

Inhab. Isle of France, New Holland. Brit. Mus.

c. Rays 5—8, elongated, subcylindrical, with 5 or 7 series of spines, the 2 lower series close together and near the ambulacra.

3. *Asterias glacialis*, Linck, t. 38, 39. *A. spinosa*, Pennant. Rays 4 or 5 times as long as the diameter of the body; spines acute. Var. 1. 8-rayed; var. 2. shorter rayed; Madeira. *m. 16. 11*

Inhab. English coast, Mediterranean.

4. *Asterias rustica*, Gray. Rays 6, flat, broad; spines short, thick, truncated. *A. salmonea m. 15. 2*

Inhab. Valparaiso, in sandy mud, *H. Cuming, Esq.* This species has a series of small triangular plates, pierced with a central triangular hole, within the marginal ambulacral spines.

5. *Asterias echinata*, Gray. Rays 8, twice as long as the width of the body, five-sided; central ridge of spines interrupted.

Valparaiso, on mud, about 4 to 6 fathoms. *H. Cuming, Esq.*

d. Rays 5, tapering; the ambulacral series of spines crowded, as if 2 or 3-rowed; back netted with a ridge of two or three rows of spines next the ambulacral series, and then a single series of spines.

6. *Asterias Holsatica*, Retz. Ast. 22. & 26. *Asterias violacea*, Müller, Z. D. ii. t. 46. *A. glacialis*, John. Rays tapering, nearly 3 times as long as the width of the body. *— 5*

Inhab. Northern Europe. Colour very variable.

7. *Asterias rubens*, Linn. Rays broad, more than twice as long as the width of the body, with scattered blunt spines, spinulose at the tip. *— 7*

Inhab. European ocean. Is not this only the female with eggs of the former?

8. *Asterias Katherinæ*, Gray. Rays 6 or rarely 5, nearly 3 times as long as the width of the body; back with scattered and crowded blunt rough-tipped spines. *Type 38 7 15 109* *— 19*

Inhab. North America, mouth of the Columbia river. *Lady Katherine Douglas.*

9 *Asterias Wilkinsonii*, Gray. Rays 5, nearly three times as long as the width of the body; back with about 7 irregular interrupted series of rather blunt rough spines, *— 19*

Inhab. Northern Africa. *Sir J. G. Wilkinson.*

See also *Ast. tenuispinosa*, Lam.; *Ast. hispida*, Penn.; *Ast. Savaresi*, Chiaje. t. 18. f. 6; and *Ast. spongiosa*, Fab.

e. Body discoidal, divided at the edge into numerous short tapering rays; the series of spines near the ambulacral series rather crowded, large and elongated. *Heliaster*, Gray.

10. *Asterias Helianthus*, Lam. 20. E. Meth. t. 108. 109. Arms

33 or 34, about $\frac{1}{4}$ the length of the width of the body, with three equidistant series of short blunt spines.

Inhab. Guasco, Chili, Say. Valparaiso, H. Cuming, Esq.

11. *Asterias Cumingii*, Gray. Arms 30 or 31, very short, not $\frac{1}{10}$ as long as the diameter of the body, conical, with blunt spines.

Inhab. Hood's Island, on rocks at spring tide. H. Cuming, Esq.

12. *Asterias multiradiata*, Gray. Arms 22 or 24, cylindrical, elongated, tapering at the ends, $\frac{1}{3}$ longer than the diameter of the body; the dorsal series of spines rather longer and more compressed.

Inhab. Hood's Island. H. Cuming, Esq.

2. TONIA, Gray.

Skeleton netted with a series of crowded small blunt mobile spines on the sides of each ossiculum; ambulacra bordered with a crowded series of subulate spines, and without any triangular pierced pieces within them.

1. *Tonia atlantica*, Gray. Rays 5, more than twice as long as the width of the body; back with 9 series of cross bands.

Inhab. Valparaiso, on rocks at low water. H. Cuming, Esq.

SECT. 2. The ambulacra with only two rows of feet.

Fam. 2. ASTROPECTINIDÆ.

Back flattish, netted with numerous tubercles, crowned with radiating spines at the tip, called Paxilli.

A. *The margin of the rays ciliated with a series of simple elongated spines, the paxilli or crowned tubercles regularly radiating.*

a. *The rays edged with a series of large regular tubercles, which increase in number as the animal grows.*

1. NAURICIA, Gray.

The ambulacral spines broad and ciliated; 2 series of tesserae between the angles of the arms and the mouth beneath. Asiatic.

1. *Nauricia pulchella*, Gray. Seba, iii. t. 8. f. 7. a. b. not good. Rays 5, half as long as the width of the body, gradually tapering, lower series of marginal tubercles with a series of broad flat spines on the upper margin of each.

Inhab. China? Japan?

2. ASTROPECTEN, Linck. Fringed Star Fish.

Ambulacral spines simple, linear, without any tesserae between the marginal tubercles near the mouth and angles of the arms.

— 1. *Body pentagonal; rays short.* —

1. *Astropecten corniculatus*, Linck. t. 27. & t. 36. f. 63.

Inhab. ———. Perhaps a variety of the next.

2. *Astropecten polaris* = *Asterias polaris*. Sabine, Append. Parry's Voy. 223. t. 1. f. 2, 3.

Inhab. North Sea.

2. *Body 5-rayed, arms depressed; the upper series of marginal tubercles broad, rounded or shelving towards the edge.*

a. *The dorsal tubercles between the angles of the arms on the centre of the back and on the lines down the centre of the arms the largest.*

3. *Astropecten stellaris.*

Inhab. ———.

b. *The dorsal tubercles subequal, with fasciculated spines.*

† *The oral series of marginal tubercles produced beyond the dorsal ones.*

* *The upper marginal tubercles with a single series of spines at the angle of the base of the rays, and with another series at the end of the rays, which together make a double series near the base of the rays.*

4. *Astropecten duplicatus*, Gray. Rays three times as long as the diameter of the body, slender; marginal spines elongated, depressed, linear.

Inhab. St. Vincent's. *Rev. L. Guilding.*

5. *Astropecten aurantiacus*. *Asterias aurantiaca*, Linn. Rays three times as long as the diameter of the body, slender; marginal spines subulate, elongated.

Inhab. Mediterranean.

6. *Astropecten stellatus*, Gray. Rays more than twice as long as the width of the body. The central area of the arms is about as wide as one series of the marginal tubercles.

Inhab. Coast of South America?

** *The upper series of marginal tubercles with a continued single series of spines on the angle of the arms.*

7. *Astropecten armatus*, Gray. Rays elongate, regularly tapering; upper marginal tubercles narrow, with a continued series of erect, elongated, subulate spines. Var. 2. *Pulcher*, the under series of marginal tubercles not produced, and the spines more slender.

Inhab. Puerto Portrero, South America, on sandy bottoms, 9 fathoms. *H. Cuming, Esq.* Var. 2.

8. *Astropecten echinatus*, Linck, 29. t. 8. f. 12. 12. Rays rather more than twice as long as the width of the body; upper series of spines large, lower series depressed, acute.

See also *Astropecten bispinosa* = *Asterias bispinosa*, Otto.

*** *The upper series of marginal tubercles spineless, the lower series much produced.*

9. *Astropecten marginatus*, Gray. Rays nearly three times as long as the width of the body; lower marginal tubercles linear, depressed.

Astropecten fimbriatus, Linck, is probably this species with the marginal spines lost.

10. *Astropecten regalis*, Gray. Rays one-fourth longer than the diameter of the body, broad, tapering; spines broad, blunt, depressed.

Inhab. St. Blas. *H. Cuming, Esq.*

Like *A. marginatus*, but the arms are shorter and broader.

**** *The upper series of marginal tubercles with 2 series of spines at the base and 1 along the edge of the arms.*

11. *Astropecten erinaceus*, Gray. Arms gradually tapering, twice as long as the width of the body; upper marginal tubercles rather narrow, with a series of small short spines, and a series of 6 or 8 larger ones.

"St. Elena, sandy mud, 6 fathoms." *H. Cuming, Esq.*

†† *The under or oral series of marginal tubercles rounded and not produced beyond the dorsal ones.*

* *The upper series with a series of short spines.*

12. *Astropecten Mauritanus*, Gray. Rays broad; lower spines broad, strap-shaped.

Inhab. Isle of France.

** *Upper series spineless.*

4/- 13. *Astropecten mesodiscus*, Linck, 29. t. 4. f. 16. Rays elongate, slender, tapering; upper marginal tubercles narrow, with 2 series of short small tubercles like granules, one on each of the margins; lower spines broad, elongate.

Inhab. —.

14. *Astropecten gracilis*, Gray. Rays elongate, slender, gradually tapering; upper marginal plates rather broad, granular with fine spines on the suture between them; lower spines small, blunt, depressed.

Inhab. —. Like the former, but arms narrower.

15. *Astropecten irregularis*, Linck, 27. t. 6. f. 13. *A. aurantiaca*, Muller, Z. D. t. 83. *A. Johnstoni*, Chiaje? Rays rather broad, tapering; the upper tubercles rather broad, with a series of 1 or 2 scattered tubercular spines near the tip; lower spines depressed, acute.

Inhab. Pembrokeshire, Linck.

16. *Astropecten dubius*. Rays broad, tapering; upper marginal tubercles rather broad, granular, spineless? lower spines broad, depressed.

Inhab. West Indies.

*** *Upper and lower margin spineless, serrated?*

17. *Astropecten regularis*, Linck, 26. t. 8. f. 11. *Asterias petalodea*, Retz, *Aster.* 16. n. 14?

Inhab. —. I have never seen this species.

3. *Body 5-rayed, the arms high, narrow; upper marginal tubercles very narrow and erect; the line of dorsal tubercles down the centre of the arms the largest. Astropus*, Gray.

18. *Astropecten longipes*, Gray. Rays long and narrow; the upper marginal tubercles minutely granular, and 1 or 2 of them often furnished with a short broad conical spine; lower with a broad depressed blunt erect adpressed spine; monstrosity 4-rayed.

Inhab. "Isle of France," Leach.

Chondrobia

See also *Ast. pentacantha*, *Ast. spinulosa*, *Ast. platycantha*, *Ast. subinermis*, Philippi, (but this author considers the number of the marginal tubercles, which increase with the age of the specimen, as a specific character,) and *Asterias calcitrapa*, Lam.

b. *The rays without any large tubercles on the margin.*

3. LUIDIA, Forbes. — 77

Margin of the 5 flat rays erect; the dorsal surface crowded with regular paxilli.

1. *Luidia fragilissima*, Forbes in Wern. Trans. 1839, 14.—*Asterias rubens*, Johnston in Mag. H. N. 144. f. 20. 77

Inhab. North Sea.

2. *Luidia Savignii*, Gray. *Ast. Savignii*, Audouin in Savigny, Egypt, Echinod. t. 3.

Inhab. Red Sea.

3. *Luidia? ciliaris*. *Asterias ciliaris*, Philippi in Wieg. Arch. 1837, 19. 77

Inhab. Sicily.

4. PETALASTER, Gray.

Margin of the rays shelving; the dorsal surface with equal paxilli placed in longitudinal and cross series. Asiatic.

1. *Petalaster Hardwickii*, Gray. Rays elongated, rather slender, tapering at the end; the dorsal tubercles with small truncated spines, and a distinct series of rudimentary spines.

Indian Ocean.

2. *Petalaster Columbia*. Rays elongated, slender, gradually tapering; tubercles short, with crowded groups of rather large acute spines, and a fringe of very fine radiating ones.

Inhab. St. Blas. H. Cuming, Esq.

B. *The margin of the rays not edged with large tubercles, simple, or ciliated with short broad spines bearing tubercles.*

5. SOLASTER, Forbes. 226

The rays many, with 2 series of broad spines bearing tubercles near the ambulacra.

a. *Body 8 or 9-rayed, closely reticulated, rays rounded, ventricose below, tapering at the tip, with a second row of compressed tubercles on the under side of the arms near the ambulacral series.* Endecca, Gray.

1. *Solaster Endecca*, Forbes. *Asterias Endecca*, Linn. *Ast. aspersa*, Muller. 26

Inhab. European Ocean.

b. *Body 10 or 12-rayed, loosely reticulated; the rays depressed, with a series of large compressed tubercles crowned with a bunch of spines edging the oral ridge.* Polyaster, Gray.

2. *Solaster papposa*, Forbes. *Asterias papposa*, Linn. *Ast. stellata*, Retz. 26

Inhab. European Ocean.

6. *HENRICIA*, Gray. *Linckia*, Forbes not Nardo.

The rays 5, rounded, tapering, with rounded tubercles near the ambulacra; the dorsal wart obscure, few rayed, often hidden with small spines.

1. *Henricia oculata*, Gray. *Asterias oculata*, Penn. *Asterias seposita*, Penn.? Rays 5, closely reticulated with small spines.

Inhab. European Ocean.

[To be continued.] → h. 275

XXIII.—*On the true Method of discovering the Natural System in Zoology and Botany.* By HUGH E. STRICKLAND, M.A., F.G.S., &c.*

It is probable that most naturalists at the present day have an instinctive belief in the existence of a natural system in Zoology and Botany, but there are very few who if questioned on the subject could give any clear explanation of the grounds of their belief, of the nature of that system, or of the mode by which a knowledge of it may be attained. The uncertainty which hangs over the subject is doubtless owing to the obscure and metaphysical nature of some of the principles involved, and still more to the vague conceptions and crude theories which have been promulgated on the subject.

This essay is contributed in the hope that, even if its own arguments are of little value, it may, at least, induce others to investigate the subject on more correct principles than have hitherto been followed.

The postulate with which I commence the inquiry is, to let it be granted that there are such things as *species*, distinct in their characters and permanent in their duration. This being admitted, we define the natural system to be *the arrangement of species according to the degree of resemblance in their essential characters*. In other words, the natural system is that arrangement in which the distance from each species to every other is in exact proportion to the degree in which the essential characters of the respective species agree. Hence it follows that the whole difficulty of discovering the natural system consists in forming a right estimate of these degrees of resemblance. For the degree in which one species resembles another must not be estimated merely by the conspicuousness or numerical amount of the points of agreement, but also by the physiological importance of these characters to the existence of the species. On this point no certain rules have yet been laid down; for though naturalists in general admit, for instance, that the

* Read before the Zoological Section at Glasgow, Sept. 21, 1840.